

## Characterization of Homemade Explosives (HMEs) by Ion Chromatography–Tandem Mass Spectrometry (IC-MS/MS)

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Homemade explosives (HMEs) and improvised explosive devices (IEDs) are commonly used in terrorist attacks throughout the world. Identification and subsequent characterization of these explosive devices are a main priority to anti-terrorism branches of the U.S. Army and other government authorities. Homemade explosive devices are usually made of materials that are easily attainable and low in cost. Typically an explosive device is composed of a fuel and an oxidizer, along with other components that improve handling properties and/or increase the heat of combustion. Inorganic salts (such as: nitrate, chlorate, and perchlorate), peroxides, fuels (such as: fuel oil, charcoal, sulfur, sugar, and some metals) are all commonly used in the production of HMEs and IEDs. In this work, we identify, characterize, and quantitate the pre-blast components of HMEs and IEDs. Table I. lists common HMEs, IEDs and their characteristic ions.

The identification, characterization, and quantitation of pre-blast components HMEs and IEDs by ion chromatography – tandem mass spectroscopy (IC-MS/MS) and ion chromatography – conductivity detection (IC-CD) is explored in this study. Conductivity chromatographs and mass spectra were acquired using a Dionex ICS-3000 ion chromatography system coupled to an Applied Biosystems (AB Sciex) API 3200 triple quadrupole mass spectrometer. Selected reaction monitoring (SRM) was used for all anion analytes except for chloride and bromide which required the use of single ion monitoring. Water soluble components were extracted from HMEs and IEDs and run under the IC-CD and IC-MS/MS methods for comparison. Ion chromatography with MS/MS detection is a sensitive, selective, and valuable technique for the pre-blast analysis of HMEs and IEDs. Ion chromatography with conductivity detection (IC-CD) is valuable for the identification of cations and elemental anions not that amenable to MS detection.

Device	Composition	Characteristic anions	Characteristic cations
ANFO	Ammonium nitrate, fuel oil	$\text{NO}_3^-$	$\text{NH}_4^+$
Black powder	Potassium nitrate, sulfur, $\text{S}_2\text{O}_3^{2-}$	$\text{NO}_3^-$ , $\text{SO}_4^{2-}$ , $\text{S}_2\text{O}_3^{2-}$	$\text{K}^+$
Chlorate/sugar	Sodium chlorate, sugar	$\text{ClO}_3^-$ , $\text{Cl}^-$	$\text{Na}^+$
Perchlorate/sugar	Potassium perchlorate, sugar	$\text{ClO}_4^-$ , $\text{Cl}^-$	$\text{K}^+$
Chlorate/sulfur/aluminum	Sodium chlorate, sulfur, aluminum	$\text{ClO}_3^-$ , $\text{Cl}^-$ , $\text{SO}_4^{2-}$ , $\text{S}_2\text{O}_3^{2-}$	$\text{Al}^{3+}$
Sturries	Ammonium nitrate, sodium nitrate, or calcium nitrate, fuels (aluminum, coal, sugar, etc.) sensitizers (nitrate salts of organic amines, nitrate esters of alcohols, perchlorate salts, aluminum)	$\text{NO}_3^-$ , $\text{ClO}_4^-$ , $\text{Cl}^-$	$\text{NH}_4^+$ , $\text{Na}^+$ , $\text{Al}^{3+}$

**Table I.** Common HMEs, IEDs and their characteristic ions.

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